PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

White Sturgeon Mitigation And Restoration In The Columbia And Snake Rivers

BPA project number: 8605000
Contract renewal date (mm/yyyy): 10/1999 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife

Business acronym (if appropriate) ODFW

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
10.4A.1; 10.4A.2; 10.4A.3; 10.4A.8; 10.4A.9

FWS/NMFS Biological Opinion Number(s) which this project addresses
Biological Opinion on White Sturgeon Restoration and Monitoring Activities in the Mainstem Columbia River and Lower Snake River, October 1998-December 2003 (October 13, 1998)

Other planning document references
Multi-Year Implementation Plan, 6.4.4.1;
Columbia River Fish Management Plan (US v. Oregon);
Wy-Kan-Ush-Mi Wa-Kish-Wit, Technical Recommendations;
White Sturgeon Management Framework (PSMFC)

Short description
Restore and mitigate for hydrosystem-caused loss of white sturgeon productivity through intensive fisheries management, supplementation, and modified hydrosystem operation. Assess success of mitigation efforts, and assess losses in unstudied areas.

Target species
White Sturgeon

Section 2. Sorting and evaluation

Subbasin
Mainstem Columbia and Snake rivers

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☐ Anadromous fish ☒ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☒ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20515	Mainstem Columbia River Umbrella Proposal
9306000	Evaluate Columbia River Select Area Fisheries
8906900	Annual Coded Wire Tag Program - Missing Production Oregon Hatcheries
8201300	Coded Wire Tag Recovery Program
8712700	Smolt Monitoring by Non-Federal Agencies
9105	Determine if Salmon Are Successfully Spawning Below Lower Columbia Dams
9600800	PATH-Participation by State & Tribal Agencies
8810804	Streamnet: The Northwest Aquatic Information Network
9007700	Northern Pikeminnow Management Program
9079	Inventory Resident Fish in Bonneville, The Dalles, & John Day Reservoirs
9705900	Securing Wildlife Mitigation Sites in Oregon
9705904	Securing Wildlife Mitigation Sites in Oregon - Horn Butte
9705911	Securing Wildlife Mitigation Sites in Oregon - Irrigon WMA Addition
9705909	Securing Wildlife Mitigation Sites in Oregon - Mitchell Point

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
8806400	Kootenai River White Sturgeon Studies and Conservation Aquaculture	Complementary work to restore white sturgeon isolated outside the geographical bounds of project 8605000.
8806500	Kootenai River Fisheries Investigations	Complementary work to study and restore white sturgeon isolated outside the geographical bounds of project 8605000.
9700900	Evaluate Means of Rebuilding White Sturgeon Populations in the Snake River	Complementary work to study and restore white sturgeon outside the geographical bounds of project 8605000.
9093	Consumptive Sturgeon Fishery - Hells Canyon and Oxbow Reservoirs	Complementary work to restore white sturgeon outside the geographical bounds of project 8605000.
9502700	Assess Limiting Factors of the Lake Roosevelt White Sturgeon Population	Results from project 8605000 will guide restoration methods used by project 9502700.
9084	Assessing Genetic Variation Among Columbia Basin White Sturgeon Populations	Genetic analyses from project 9084 will be used to guide supplementation and propagation developed by project 8605000.
9603201	Begin Implementation of Year 1 of the K-Pool Master Plan Program	Propagation techniques developed as part of project 8605000 will be used by project 9603201.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1988	Developed methodologies: Habitat mapping and modeling; capture gears for various life stages; marking and aging techniques.	Yes, results published in peer review journals (see Section 8d).
1992	Determined that dams limit movements of white sturgeon and have functionally isolated populations in mainstem Columbia River reservoirs.	Yes, results published in peer review journals
1992	Described population dynamics and found them to be unique in each reservoir.	Yes, results published in peer review journals

1992	Found population productivity to be 10-100 times higher downstream from Bonneville Dam than in Bonneville, The Dalles, or John Day reservoirs.	Yes, results published in peer review journals
1992	Identified reduced flows and subsequent poor recruitment as the key factor limiting white sturgeon productivity in impoundments.	Yes, results published in peer review journals
1992	Determined reservoirs provide large areas of suitable habitat for juvenile and adult white sturgeon, but compensatory population responses may reduce productivity if carrying capacity is exceeded.	Yes, results published in peer review journals
1992	Determined over-fishing had occurred in the three lowermost reservoirs of the Columbia. Described appropriate exploitation rates under the reduced productivity resulting from the development and operation of the hydrosystem.	Yes, results published in peer review journals
1997	Demonstrated increased abundance of white sturgeon in The Dalles and John Day reservoirs. Some of this recovery was attributable to intensive harvest management and reduced exploitation.	Yes, results presented in annual reports.
1997	Transplanted white sturgeon to The Dalles Reservoir and demonstrated survival and growth of those fish one and two years later.	Yes, results presented in annual reports.
1997	Completed initial population estimates for white sturgeon in Ice Harbor, Little Goose, and Lower Monumental reservoirs.	Yes, results presented in annual reports.
1997	Determined that white sturgeon larvae are susceptible to gas bubble trauma in laboratory experiments.	Yes, results published in peer-review journal.
1998	Developed habitat maps and flow-habitat models for the Columbia River up to Priest Rapids Dam.	Yes, results presented in annual reports.
1998	Used index sampling to develop initial descriptions of white sturgeon populations in Rock Island Reservoir, Lake Rufus Woods, and Lake Roosevelt.	Yes, results being summarized for annual report.
1998	Documented presence of species-specific viral pathogens in wild Columbia River	Yes, results being summarized for peer review journal.

	white sturgeon.	
1998	Developed two indices to index the relative abundance for age-0 white sturgeon.	Yes, results accepted for publication in peer-review journal.
1998	Determined that hydropeaking at The Dalles Dam displaces white sturgeon eggs and larvae from incubation areas	Yes, results accepted for publicationin peer-review journal.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Develop and implement mitigation actions that do not involve changes to hydrosystem operation and configuration.	a	Transplant approximately 10,000 juvenile white sturgeon from areas downstream from Bonneville Dam to The Dalles and John Day reservoirs (ODFW).
		b	Collect, hold, and spawn wild white sturgeon to produce age-specific cohorts and evaluate the feasibility of using artificial propagation as a mitigation tool (CRITFC).
		c	Conduct laboratory experiments to determine the size at which artificially-propagated sturgeon should be stocked to avoid predation (USGS).
		d	Continue intensive fisheries management and monitoring of harvest in Bonneville, The Dalles, and John Day reservoirs (WDFW, ODFW, and CRITFC).
2	Develop and implement mitigation actions that involve changes to hydrosystem operation and configuration.	a	Describe the effects of daily dam operations on spawning by white sturgeons by using telemetry to monitor behavior of pre-spawn and spawning fish (USGS).
		b	Describe the effects of dam operations on recruitment by correlating habitat measures with indices of recruitment (USGS and USFWS).
		c	Describe the potential effect of proposed reservoir drawdowns on

			the physical habitat available for white sturgeons in John Day, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite reservoirs (USGS).
3	Monitor and evaluate actions to mitigate for lost white sturgeon production due to development, operation, and configuration of the hydropower system.	a	Determine if the indices developed from trawling and gillnetting follow similar trends with changes in densities that result from variable recruitment (WDFW and USGS).
		b	Describe annual variation in white sturgeon recruitment from catches of age-0 fish in 24-hour gill net sets (2 inch stretched mesh) in The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, and Little Goose reservoirs (WDFW, ODFW, and CRITFC).
4	Assess losses to white sturgeon productivity caused by development and operation of the hydrosystem.	a	Determine if reduced turbidity caused by hydropower system development influences predation on age-0 white sturgeons (USGS).
		b	Determine sex, maturational status, and reproductive potential of sturgeon in impounded and unimpounded reaches and correlate disease load with reproductive fitness (ODFW).

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1997		Increased abundance of white sturgeon through supplementation, artificial propagation, and intensive management.		50.00%
2	10/1997		Increased productivity of white sturgeon		14.00%

			through optimal hydrosystem operation.		
3	10/1997		Documentation of increased abundance and productivity.		30.00%
4	10/1997	9/2002	Assessment of hydrosystem impacts on productivity.	Complete research by 2002	6.00%
				Total	100.00%

Schedule constraints
If the project is funded, no substantial constraints are likely. Possible constraints include delays in NMFS consultations, and coordination of supplementation and propagation activities.

Completion date
Most research tasks will be complete by 2002. Remaining tasks are mitigation actions resulting from research findings, and monitoring the effectiveness of these actions. Mitigation may need to continue indefinitely.

Section 5. Budget

FY99 project budget (BPA obligated): $2,002,028

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	ODFW = $187,789 WDFW = $228,900 USGS = $203,005 USFWS = $35,237 CRITFC = $83,946	%39	738,877
Fringe benefits	ODFW = $76,993 WDFW = $59,200 USGS = $60,901 USFWS = $8,780 CRITFC = $26,443	%12	232,317
Supplies, materials, non-expendable property	ODFW = $14,160 WDFW =$4,300 USGS = $19,600 USFWS = $700 CRITFC = $3,400	%2	42,160
Operations & maintenance	ODFW = $46,645 WDFW = $26,700	%6	123,647

	USGS = $42,760 USFWS = $0 CRITFC = $7,542		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	
NEPA costs		%0	
Construction-related support		%0	
PIT tags	# of tags:	%0	
Travel	ODFW = $28,803 WDFW = $36,300 USGS = $5,200 USFWS = $0 CRITFC = $6,250	%4	76,553
Indirect costs	ODFW = $125,808 WDFW = $71,100 USGS = $125,957 USFWS = $15,293 CRITFC = $47,406	%20	385,564
Subcontractor	NMFS (from ODFW)	%2	45,000
Subcontractor	Oregon State University (from ODFW)	%5	100,517
Subcontractor	Yakama Indian Nation (from CRITFC)	%3	48,885
Subcontractor	Abernathy Salmon Technology Center (from CRITFC)	%7	125,641
Other		%0	
TOTAL BPA FY2000 BUDGET REQUEST			$1,919,161

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
ODFW	Personnel, office supplies	%4	100,059
WDFW	Personnel, vehicles, office supplies	%8	187,660
USGS	Personnel, field supplies, computer support	%1	13,723
USFWS	Personnel, travel	%0	3,312
CRITFC		%0	0
Total project cost (including BPA portion)			$2,223,915

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$1,950,000	$1,950,000	$1,500,000	$1,500,000

Section 6. References

Watershed?	Reference
☐	Beamesderfer, R. C. and A. A. Nigro, editors. 1993. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Final Report to Bonneville Power Administration Contract No. DE-A179-86BP63584
☐	Columbia Basin Fish and Wildlife Authority. 1997. Multi-year implementation plan for the protection, restoration, and enhancement of Columbia River Basin fish and wildlife resources. Presented to the Northwest Power Planning Council, Portland, OR.
☐	Columbia River Fish Management Plan. 1988. (An agreement ordered by the Unites States District Court for the District of Oregon in the case of United States et al. v. Oregon et al., Civ. 68-153), as amended by the Court, Portland, OR.
☐	Columbia River Inter-Tribal Fish Commission. 1995. Wy-Kan-Ush-Mi Wa-Kish-Wit ; The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes, Volume 1., Portland, OR.
☐	Craig, J. A., and R. L. Hacker. 1940. Sturgeon fishery of Columbia River Basin. Bulletin of the Bureau of Fisheries 49:204-208.
☐	DeVore, J. D., B. Parker, R. C. P. Beamesderfer, and T. A. Rien. 1998. A review of alternatives for the restoration and management of white sturgeon populations and fisheries in the Columbia River between Bonneville and McNary dams. WDFW.
☐	Fickeisen, D. H., D. A. Neitzel, and D. D. Dauble. 1984. White sturgeon research needs: workshops results. Division of Fish and Wildlife, Bonneville Power Administration, U. S. Department of Energy, Portland, OR.
☐	Hedrick, R. P., T. S. McDowell, J. M. Groff, S. Yun, and W. H. Wingfield. 1992. Isolation and some properties of an iridovirus-like agent from white sturgeon Acipenser transmontanus. Diseases of Aquatic Organisms 12:75-81.
☐	McCabe, G. T., Jr. and C. A. Tracy 1994. Spawning and early life history of white sturgeon, Acipenser transmontanus, in the lower Columbia River. Fishery Bulletin 92:760-772.
☐	Pacific States Marine Fisheries Commission. 1992. White sturgeon management framework plan. Portland, OR.
☐	Parsley, M.J., and L.G. Beckman. 1994. White Sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.
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PART II - NARRATIVE

Section 7. Abstract

Project goals are to (1) implement and evaluate measures to protect and restore white sturgeon populations downstream from McNary Dam, and (2) determine the need and identify potential measures to protect and restore white sturgeon populations upstream from McNary Dam. This project includes a series of closely coordinated and complementary activities being implemented in an orderly progression from initial problem scoping to full scale restoration and mitigation. This approach is consistent with FWP measure 10.4 which directs that "studies and evaluations should be undertaken and completed quickly, and on-the-ground projects identified and implemented as soon as possible". The project directly addresses FWP measures 10.4A.1, 10.4A.2, 10.4A.3, 10.4A.8, and 10.4A.9. This is the only project conducting field activities to restore populations in the Columbia River downstream from Lake Roosevelt, and in the Snake River downstream from Lower Granite Dam.

Initial project activities from 1986-92 indicated that productivity of white sturgeon in Bonneville, The Dalles, and John Day reservoirs was severely limited. Recommendations included increasing management of fisheries for impounded populations, identifying habitat requirements and the relationship between river discharge and productivity, evaluating the feasibility of restoration through transplants and artificial propagation, and investigating the need for protecting and restoring populations upstream from McNary Dam.

Work since 1992 has been based on these recommendations. Project activities include intensive management of fisheries in impoundments. Transplanting wild juvenile white sturgeon for supplementation was implemented as a mitigation action in 1998 and will continue to be used. Effects of mitigation actions such as intensive management and supplementation will be assessed through periodic sampling (every five years in each reservoir) to index populations. Initial indexing indicated that abundance in The Dalles and John Day reservoirs has increased as a result of mitigation. We completed habitat mapping in the Columbia River downstream from Priest Rapids Dam in 1999, and have developed a broad recommendation for flows to provide spawning habitat in impoundments. We will continue work to facilitate our understanding of the relationship between flow and spawning. In 1999 we began work to refine and evaluate conservation-based hatchery technology. Work in 2000 may include the first experimental release of propagated juveniles. Populations we have assessed upstream from McNary Dam are severely depressed, usually due to lack of spawning success. We will continue to index

the remaining populations and will phase in suitable mitigation and restoration actions based on feasibility evaluations in downstream reservoirs.

Section 8. Project description

a. Technical and/or scientific background

White sturgeon populations in the Columbia River downstream from Bonneville Dam support one of the most productive recreational and commercial sturgeon fisheries in the world (Craig and Hacker 1940; McCabe and Tracy 1994) However, populations impounded in Bonneville, The Dalles, and John Day reservoirs can support only limited recreational and tribal fisheries and are more vulnerable to overfishing than the unimpounded population. Sturgeon populations upstream from McNary Dam can support only limited harvest or catch-and-release recreational fisheries.

Development of the Columbia River basin hydrosystem has severely impacted populations of white sturgeon upstream from Bonneville Dam. Impoundments severely restrict movements of white sturgeon and two of their principle food sources (eulachon *Thaleichthys pacificus* and Pacific lamprey *Lampetra tridentata*). The hydrosystem has also destroyed or degraded white sturgeon spawning habitat. Construction and operation of dams altered the flow regime and increased water depths, which resulted in reduced water velocities over extensive areas (Parsley and Beckman 1994). As a result, many impounded white sturgeon populations are not as productive as they once were, and some populations in upper reaches of the Columbia River basin may face extirpation.

Concern about the effects of the hydrosystem on white sturgeon led to a *White Sturgeon Research Needs* workshop in 1983 (Fickeisen et al. 1984), and eventually to this project in 1986. From 1986-92, work concentrated on determining the status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam (Beamesderfer and Nigro 1993). Conclusions from this work included (1) dams limit movements of white sturgeon and have functionally isolated populations, (2) the status and dynamics of each population are unique, (3) productivity in reservoirs is less than in the unimpounded area downstream from Bonneville Dam, (4) recruitment and subsequent population size are limited by the effects of river discharge on spawning habitat, which is restricted to high-velocity areas immediately downstream from dams, (5) reservoirs provide large areas of suitable habitat for juvenile and adult white sturgeon, but compensatory population responses may reduce productivity if carrying capacity is reached, and (6) fisheries for white sturgeon in The Dalles and John Day reservoirs collapsed and population collapse was likely if high exploitation continued.

Based on these conclusions, recommendations for further work included (1) intensify management of fisheries for impounded populations, (2) evaluate if augmented river discharge in May and June improves spawning and recruitment, (3) evaluate the feasibility of enhancing depleted populations by transplanting juvenile white sturgeon from populations downstream from Bonneville Dam, (4) identify habitat requirements of subadult and adult white sturgeon, quantify amounts of suitable habitat, and evaluate constraints on enhancement, (5) refine and evaluate hatchery technology for enhancement of threatened populations of white sturgeon, and (6) investigate the need and potential measures for protecting and enhancing populations upstream from McNary Dam.

Work since 1992 has been based on these recommendations. Project activities have included and will continue to include intensive management of fisheries in Bonneville, The Dalles, and John Day reservoirs. We have developed a broad recommendation for flows that will provide spawning habitat in Bonneville, The Dalles, and John Day

reservoirs, but we do not yet know which specific hydro-facility operations will stimulate spawning in tailrace areas. Continuing work to estimate age of white sturgeon eggs within hours will facilitate our understanding of these relationships. We have determined that enhancing depleted populations in The Dalles and John Day reservoirs by transplanting juvenile fish from the area downstream from Bonneville Dam is feasible. Transplants were implemented as a mitigation action in 1998, and will be continued as an ongoing component of the project. Project activities have included intensive mapping of available habitat, which was completed in 1999. A final report of these activities will include recommendations for hydrosystem operations that will enhance physical habitat conditions. In 1999 we began work to refine and evaluate hatchery technology. Propagation may be a suitable mitigation action for impoundments where transplants are not logistically feasible, or where genetic constraints do not allow transplants of fish from one area to another. Work since 1992 has shown that populations upstream from McNary Dam are severely depressed, usually due to lack of spawning success. We are continuing to assess the status of these populations; substantial work has been completed in three lower Snake River reservoirs, and in four Columbia River reservoirs upstream from McNary Dam. This will allow us to assess losses caused by the hydrosystem in this area of the basin.

b. Rationale and significance to Regional Programs

This project will contribute to the FWP goal of providing a healthy Columbia River basin that supports human settlement and long-term sustainability of native fish. Actions to protect and restore populations and mitigate for effects of the hydropower system will increase productivity of white sturgeon in the basin. Therefore, measure 10.4A of the FWP calls for the study and evaluation of sturgeon populations: “The Council believes that studies and evaluations should be undertaken and completed quickly, and on-the-ground projects identified and completed as soon as possible to address the needs of this species. In addition, these studies should be coordinated to avoid redundant work and to increase the potential for learning.” Measure 10.4A.2 further states that "Specific recommendations for the protection, mitigation, and enhancement of sturgeon may be submitted to the Council upon completion of these studies.”

Work to address Measure 10.4A.2 (determine the impact of the hydrosystem on sturgeon) is nearly complete. Work that is well underway but not complete includes tasks associated with Objective 2. Tasks involve (a) describing the relationship between specific dam operations and onset of spawning, (b) determining the relationship between river discharge and recruitment, and (c) describing the potential effect of reservoir drawdowns on white sturgeon productivity. In addition, completion of Task 3b, describing annual variation in recruitment of white sturgeon, will provide data to determine if relationships between river velocity in spring and densities of age-0 fish are consistent among impoundments and over time.

Work to address Measure 10.4A.3 (evaluate potential means of rebuilding sturgeon populations between Bonneville Dam and the mouth of the Snake River) is also nearly complete. Task 1a, annually transplanting juvenile white sturgeon from areas below Bonneville Dam to The Dalles and John Day reservoirs, is one of the means of rebuilding these populations. Task 1d, intensive annual harvest management in Bonneville, The Dalles, and John Day reservoirs, is another means.

Measure 10.4A.8 (development of an experimental white sturgeon facility for research on contaminants, reproduction, and genetics) is directly addressed by Tasks 1b and 1c, developing artificial propagation techniques and protocols. Results from these tasks will eventually address Measures 10.4A.2 (potential for artificial propagation), and 10.4A.3

(rebuilding sturgeon populations). Long-term implementation of artificial propagation is not an objective of this project. Technologies and strategies we develop will be transferred to appropriate management agencies through publication and work groups.

Measure 10.4A.9 (white sturgeon population research in Lake Roosevelt, mid-Columbia, and lower Snake River reservoirs) is directly addressed by Objective 4. Population assessment and indexing has provided information on distribution, recruitment, and age composition of white sturgeon in these areas. Recommendations for management actions will be made after each reservoir is sampled.

In addition to the FWP, actions to protect and restore populations and mitigate for effects of the hydrosystem on productivity of white sturgeon have been called for in the "Columbia River Fish Management Plan" (*US v. Oregon*), in the "Multi-Year Implementation Plan" of the CBFWA, and in "Wy-Kan-Ush-Mi Wa-Kish-Wit" (the anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs and Yakama tribes). Recommended actions from earlier work are described in "A Review of Alternatives for the Restoration and Management of White Sturgeon Populations and Fisheries in the Columbia River Between Bonneville and McNary Dams (Zone 6)" (DeVore et al. 1998). These recommendations are being implemented and assessed under this project as specific measures that can protect and restore populations and mitigate for effects of the hydropower system on productivity of white sturgeon in the three-pool area between Bonneville and McNary dams.

The study goals correspond to those of the "White Sturgeon Research Program Implementation Plan" developed by BPA in cooperation with state and federal fishery agencies, tribes, universities, and the private sector, and approved by the Northwest Power Planning Council in 1985. The earlier phases of the study focused on high priority information needs conducted in high priority areas, as designated in this plan. The study also addresses research priorities described in the White Sturgeon Management Framework completed by the Pacific States Marine Fisheries Commission in 1992.

The consequences to white sturgeon are severe if the project is not funded. Without intensive management, current levels of harvest can not be maintained, and potential future increases will be precluded. Production of white sturgeon in most reservoirs will remain extremely limited, and abundance of severely depressed populations will remain critically low. Production will be limited by operation of the hydrosystem, and abundance will remain low because depressed reservoir populations will not be supplemented. White sturgeon are a species of historic commercial, recreational, and tribal importance, and loss of these populations is significant and unacceptable. Closure of fisheries would likely result in litigation; therefore, annual funding is essential to maintain and increase current harvest levels.

c. Relationships to other projects

This project is a component of the *Mainstem Columbia River Umbrella Proposal*. One of the objectives of the umbrella is to maintain and restore production of white sturgeon in the Columbia and Snake rivers. Strategies to meet this objective include (1) protecting and enhancing habitat by providing appropriate flows through dam operations, and (2) using supplementation and artificial propagation to increase abundance of populations depressed by poor reproduction. These strategies correspond to the goals of this project, and are specifically addressed by objectives 1 and 2.

Although there is no umbrella proposal covering all the white sturgeon projects in the Columbia River basin, work is well coordinated among these projects. This project is the only one conducting field activities to restore populations in the Columbia River

downstream from Lake Roosevelt, and in the Snake River downstream from Lower Granite Dam. Project 8806400, *Kootenai River White Sturgeon Studies and Conservation Aquaculture*; Project 8806500, *Kootenai River Fisheries Investigations*; Project 9700900, *Evaluate Means of Rebuilding White Sturgeon Populations in the Lower Snake River*; and Project 9093, *Consumptive Sturgeon Fishery – Hells Canyon and Oxbow Reservoirs*; are all designed to study and restore sturgeon populations outside the geographic scope of this project; therefore, these projects are all complementary.

Staff from these projects communicate to compare techniques and prevent duplication of effort. For example, staff from our project communicated with staff from Project 8806400 to ensure that propagation effort was not duplicated. Project 8806400 uses artificial propagation to stabilize and maintain an endangered species, not to enhance or expand a population to meet recovery goals. Their breeding and release strategies are defined by the recovery plan. Conversely, this project's proposal is to use and improve upon current technology regarding capture, holding, and breeding of wild white sturgeon that are currently not listed, and therefore subject to fewer restrictions. This allows for greater, although prudent, levels of experimentation, particularly in areas that evaluate the efficacy of different release sizes and densities. Our findings may be particularly useful to the recovery of Kootenai River white sturgeon.

This project has completed a baseline assessment of population status in Lake Roosevelt; therefore, coordination with Project 9502700, *Assess Limiting Factors of the Lake Roosevelt White Sturgeon Population*, is critical to ensure that work is not duplicated. To date, project 9502700 has not been funded to conduct field work. Early results from our 1998 work in Lake Roosevelt indicate that further assessments of population status are probably not necessary; therefore, the next step may be to develop a joint-agency recovery plan that should consider supplementation.

Our work is complementary with that of project 9084, *Assessing Genetic Variation Among Columbia Basin White Sturgeon Populations*. Results from Project 9084 will provide guidelines for the transportation of juvenile sturgeon from the area downstream from Bonneville Dam to upstream reservoirs. Results should also provide guidelines for the release of artificially propagated juveniles. Project 9084 realizes significant cost savings because our project provides many of the white sturgeon tissues used in the genetic analyses (at no added cost).

We have participated in the technical work group for project 9603201, *Begin Implementation of Year 1 of the K-Pool Master Plan Program*. Results from our task to investigate propagation techniques will be used by project 9603201 when it begins production. Staff from project 9603201 will work at our research facility, part time, to ensure technology transfer.

Eventual release of artificially propagated juvenile white sturgeon will require compliance with the NEPA process. This activity, which may occur in 2000, will be coordinated with NPPC staff. As a first step in this process, we have completed a peer-reviewed research plan to analyze capture, spawning, and rearing aspects of artificial propagation.

d. Project history (for ongoing projects)

History

This project began in 1986 with the title *Status and Habitat Requirements of White Sturgeon Populations in the Columbia River Downstream from McNary Dam*. The title has since changed, but the project number has not. As the original title indicates, the early focus of the study was to provide information on the status of white sturgeon

populations in the lower Columbia River. Objectives were (1) describe reproduction and early life history characteristics of white sturgeon populations, (2) describe the life history and population dynamics of subadult and adult white sturgeon, (3) define habitat requirements for spawning and rearing of white sturgeon and quantify extent of habitat available, and (4) evaluate the need and identify potential methods for protecting, mitigating, and restoring white sturgeon populations. BPA contracted with the Oregon Department of Fish and Wildlife (ODFW) to conduct the study, and ODFW subsequently entered into cooperative agreements with the Washington Department of Fish and Wildlife (WDFW), what is now the U.S. Geological Survey – Biological Resources Division (USGS), and the National Marine Fisheries Service (NMFS) to conduct portions of the study. In general, Objectives 1 and 3 were addressed by USGS and NMFS, whereas Objectives 2 and 4 were addressed by ODFW and WDFW.

As described in Section 8a, work from 1986-92 resulted in conclusions concerning the status of white sturgeon populations downstream from McNary Dam, and in recommendations for further work. These recommendations included a mix of mitigation actions and research activities designed to increase efficacy of these mitigation actions. Work since 1992 has focused on developing and implementing the mitigation actions recommended, monitoring the effects of these actions, and conducting the research activities recommended. To reflect this change in direction, the title of the project changed to *Effects of Mitigative Measures on Productivity of White Sturgeon Populations in the Columbia River Downstream From Bonneville Dam, and Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream From McNary Dam*.

With this new phase of the project, the U.S. Fish and Wildlife Service (USFWS) and the Columbia River Inter-Tribal Fish Commission (CRITFC) joined as cooperators. From 1993-97 ODFW addressed recommendations 1, 3, 4, and 6 (see Section 8a); WDFW addressed recommendations 1, 2, 3, and 6; USFWS addressed recommendation 4; NMFS addressed recommendations 1 and 4; USGS addressed recommendations 2, 3, and 4, and CRITFC addressed recommendation 1. NMFS completed their work in 1997 and ended their status as project cooperators.

By 1998, much of the recommended work had been completed or was well underway: recommendation 1 had become an ongoing component of the project, work to address recommendation 3 was complete, and work to address recommendations 2 and 4 had resulted in a broad recommendation for flows to provide spawning habitat. Therefore, a new phase of the project was started. This is the current phase of the project, scheduled to last from 1998-2002. In this phase, mitigation actions resulting from recommendations 1 and 3 are being fully implemented, investigations resulting from recommendations 2, 4 and 6 are nearing completion, and work to address recommendation 5 is underway. When this current phase of the project ends, future work will be focused almost entirely on mitigation activities and monitoring the effects of those activities.

Reports and Technical Papers

Final report from the first phase of the project:

Beamesderfer, R. C. and A. A. Nigro. 1993 . Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam: Annual Report to Bonneville Power Administration, Contract No. DE-A179-86BP63584.

The correct citation for each of the following reports from the second phase of the project is “Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream From McNary

Dam. Annual Report to Bonneville Power Administration, Contract No. DE-A179-86BP63584."

Beamesderfer, R. C. and A. A. Nigro. 1993.
Beiningen, K. B. 1995.
Beiningen, K. B. 1996.
Beiningen, K. B. In Press.
Ward, D. L. In Press.

The first annual report for the current phase of the project, "White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers Upstream from Bonneville Dam", is in preparation.

The following list of peer-review journal articles and special reports have been produced as part of the project:

Beamesderfer, R.C. 1991. MOCPOP 2.0: A flexible system for simulation of age-structured populations and stock related functions. Oregon Department of Fish and Wildlife Information Report 91-4.

Beamesderfer, R.C. 1993. A standard weight (Ws) equation for white sturgeon. California Fish and Game 79(2):63-69}

Beamesderfer, R.C.P., T.A. Rien, and A.A. Nigro. 1995. Dynamics and potential production of white sturgeon populations in three Columbia River reservoirs Transactions of the American Fisheries Society 124:857-872.

Counihan, T.D., and C.N. Frost. In Press. Influence of externally attached transmitters on the swimming performance of juvenile white sturgeon. Transactions of the American Fisheries Society.

Counihan, T.D., A.I. Miller, and M.J. Parsley. In Press. Indexing the relative abundance of age-0 white sturgeon in an impoundment of the lower Columbia River from highly skewed trawling data. North American Journal of Fisheries Management.

Counihan, T.D., A.I. Miller, M.G. Mesa, and M.J. Parsley. 1998. The effects of dissolved gas supersaturation on white sturgeon larvae. Transactions of the American Fisheries Society 127:316-322.

DeVore, J.D., B.W. James, C.A. Tracy, and D.A. Hale. 1995. Dynamics and potential production of white sturgeon in the Columbia River downstream from Bonneville Dam. Transactions of the American Fisheries Society 124:845-856.

Elliott J.C. and R.C. Beamesderfer. 1990. Comparison of efficiency and selectivity of three gears used to sample white sturgeon in a Columbia River reservoir. California Fish and Game 76(3):174-180.

McCabe, G.T., Jr. 1993. Prevalence of the parasite *Cystoopsis acipenseri* (Nematoda) in juvenile white sturgeons in the lower Columbia River. Journal of Aquatic Animal Health 5(4):313-316.

McCabe, G.T., Jr. and L.G. Beckman. 1990. Use of an artificial substrate to collect white sturgeon eggs. California Fish and Game 76(4):248-250.

McCabe, G.T., Jr., R.L. Emmett, and S.A. Hinton. 1993. Feeding ecology of juvenile white sturgeon (*Acipenser transmontanus*) in the Lower Columbia River. Northwest Science 67(3):170-180.

North, J.A., R.C. Beamesderfer, and T.A. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia River reservoirs. Northwest Science 67(2):105-111.

Parsley, M.J., and L.G. Beckman. 1994. White sturgeon spawning and rearing habitat in the Lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Parsley, M.J., L.G. Beckman, and G.T. McCabe, Jr. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society 122(2):217-227.

Rien, T.A., and R.C. Beamesderfer. 1994. Accuracy and precision in age estimates of white sturgeon from pectoral fin rays. Transactions of the American Fisheries Society 123(2):255-265.

Rien, T.A., R.C.P. Beamesderfer, and C.A. Foster. 1994. Retention, recognition, and effects on survival of several tags and marks on white sturgeon. California Fish and Game 80(4):161-170.

Warren, J.J. and L.G. Beckman. 1993. Fishway use by white sturgeon to bypass mainstem Columbia River dams. U.S. Fish and Wildlife Service Sea Grant Extension Project, Columbia River Series WSG-AG 93-02.

Summary of Major Results

From 1986-88 we developed methodologies for habitat mapping and modeling, capture gears for various life stages, and marking and aging techniques.

By 1992, we

Determined that dams limit movements of white sturgeon and have functionally isolated populations in mainstem Columbia River reservoirs;

Described population dynamics and found them to be unique in each reservoir;

Found population productivity to be 10-100 times higher downstream from Bonneville Dam than in Bonneville, The Dalles, or John Day reservoirs;

Identified reduced flows and subsequent poor recruitment as the key factor limiting white sturgeon productivity in impoundments;

Determined reservoirs provide large areas of suitable habitat for juvenile and adult white sturgeon, but compensatory population responses may reduce productivity if carrying capacity is exceeded;

Determined over-fishing had occurred in the three lowermost reservoirs of the Columbia, and described appropriate exploitation rates under the reduced productivity resulting from the development and operation of the hydrosystem.

By 1997, we

Demonstrated increased abundance of white sturgeon in The Dalles and John Day reservoirs, which was attributable to intensive harvest management and reduced exploitation;

Transplanted white sturgeon to The Dalles Reservoir and demonstrated excellent survival and growth of those fish one and two years later;

Completed initial population estimates for white sturgeon in McNary, Ice Harbor, Little Goose, and Lower Monumental reservoirs, and the Hanford Reach.

By 1998, we

Developed habitat maps and flow-habitat models for the Columbia River up to Priest Rapids Dam;

Used index sampling to develop initial descriptions of white sturgeon populations in Rock Island Reservoir, Lake Rufus Woods, and Lake Roosevelt;

Documented presence of species-specific viral pathogens in wild Columbia River white sturgeon;

Developed two indices of relative abundance for age-0 white sturgeon;

Determined that white sturgeon larvae are susceptible to gas bubble trauma in laboratory experiments;

Determined that hydropeaking at The Dalles Dam displaces white sturgeon eggs and larvae from incubation areas.

Adaptive Management Implications

The evolution of this project through its three phases are the best indication of adaptive management. From 1986-92, work focused on research in the Columbia River downstream from McNary Dam. From 1993-97, work focused on recommendations resulting from the initial research. This work focused on developing mitigation actions and conducting further research to refine mitigation actions. Since 1998, work has focused on implementing mitigation actions, monitoring the effects of those actions, and finishing up research activities. After 2002, work will focus almost entirely on mitigation actions and monitoring the effects of those actions.

Findings from the project have provided fishery managers with the opportunity for adaptive management. The need for intensive management of fisheries in impoundments was made clear by project findings, and the added effort for intensive management is part of the project.

Years Underway and Past Costs

The project has been underway since 1986. Cost from 1986-99 has been $15,509,943.

e. Proposal objectives

(1) Develop and implement mitigation actions that do not involve changes to hydrosystem operation and configuration.

(2) Develop and implement mitigation actions that involve changes to hydrosystem operation and configuration.

(3) Monitor and evaluate actions to mitigate for lost white sturgeon production due to development, operation, and configuration of the hydropower system.

(4) Assess losses to white sturgeon productivity caused by development and operation of the hydrosystem.

These four objectives are designed to meet the project goals, which are (1) implement and evaluate measures to protect and restore white sturgeon populations downstream from McNary Dam, and (2) determine the need and identify potential measures to protect and restore white sturgeon populations upstream from McNary Dam. The objectives include a range of specific tasks that include mitigation actions, monitoring the effects of mitigation actions, and research.

Objective 1 includes mitigation actions (Tasks 1a and 1d), and research activities (Tasks 1b and 1c) designed to increase efficacy of mitigation actions. Transplanting juvenile white sturgeon to impounded areas (Task 1a) mitigates for lost production by supplementing depressed populations. Intensive fisheries management (Task 1d) is needed to protect and restore populations depressed by the hydrosystem, and is therefore

considered mitigation. Artificial propagation (Task 1b) will eventually be a mitigation tool; however, our efforts are focused on improving current technology regarding capture, holding, and breeding, and rearing of white sturgeon. We will evaluate the efficacy of different release sizes and densities. The overall hypothesis to be tested is *Ho*: *release of artificially propagated white sturgeon has no effect on population abundance.* A supporting activity is to determine the size at which artificially propagated white sturgeon are no longer subject to predation. The hypothesis to be tested is *Ho: white sturgeon size has no effect on vulnerability to predation.*

Objective 2 consists of research activities designed to provide information on how to operate the hydrosytem for maximum benefit to white sturgeon. Describing the effects of daily dam operations (Task 2a) allows us to test *Ho: hourly discharge patterns have no effect on fish movements prior to and during spawning.* For Task 2b, we will (a) construct daily time series to quantify spawning habitat available in 2000, and (b) use this information in concert with previous years' data and recruitment indices (Task 3b) to test *Ho: hydrosystem operation has no effect on recruitment of white sturgeon*. For Task 2c, we will use existing data on habitat use by white sturgeon and habitat availability if reservoirs are lowered to test *Ho: reservoir drawdowns will have no effect on white sturgeon production.*

Objective 3 is focused on monitoring the effects of mitigation actions. This includes periodic updates on status of white sturgeon populations; however, no updates are scheduled for 2000. Status of the population in Bonneville Reservoir was updated in 1999; John Day and The Dalles reservoirs will be updated in 2001 and 2002. Another component of this objective is to monitor reproductive success under present and future hydrosystem operations. For Task 3a, we will use catches of age-0 white sturgeon to test *Ho: trends in* indices *of recruitment derived from gillnetting and bottom trawling do not differ*. Appropriate indices (Task 3b) will then be used to assess hydrosystem operations as explained for Task 2b.

The purpose of Objective 4 is to continue to investigate how hydrosystem development has affected white sturgeon productivity. For Task 4a, we will use laboratory experiments to test *Ho: turbidity has no effect on predation on larval and juvenile white sturgeon*. Work to perfect non-invasive techniques for determining maturational status and disease load (Task 4b) will allow us to test (1) *Ho: reproductive potential does not differ between impounded and unimpounded reaches,* and (2) *Ho: disease load not does differ between impounded and unimpounded reaches.*

Products resulting from this project have included, and will continue to include (1) transfer of information to fishery managers, (2) annual reports published by BPA, (3) manuscripts published in peer-review journals, and (4) sturgeon workshops and symposia.

f. Methods

Objective 1 (Develop and implement mitigation actions that do not involve changes to hydrosystem operation and configuration).

Task 1a-The ODFW will transplant 10,000 white sturgeon and release them in The Dalles and John Day reservoirs. The NMFS will be subcontracted to capture juvenile white sturgeon in the Columbia River (river mile 130 - 132) using their vessel and a 6.2-m semi-balloon shrimp trawl. White sturgeon 35-cm to 90-cm fork length will be counted as they are transferred from the trawler to 300-L plastic totes on a barge. All white sturgeon will be marked to indicate year of transplant., and fork length of 100 fish will be measured each day. After marking and measuring, all fish will be transferred into a fish

liberation truck parked on the barge. Upon reaching the daily capacity (about 1,400 fish), or at the scheduled departure time the barge will be moved to a ramp at river mile 140 by a subcontracted tow boat. The liberation truck will be driven off the barge and the fish will be transported to selected release sites in The Dalles and John Day reservoirs.

Recoveries of marked transplants in periodic stock assessments in The Dalles and John Day reservoirs (conducted about every five years) will provide information on growth and relative abundance. These will be used to monitor the effectiveness of transplanting white sturgeon.

Task 1b-With assistance from WDFW, the CRITFC will collect wild white sturgeon from the Columbia River upstream from Priest Rapids Dam, and hold them in preparation for spawning in spring. Spawning and rearing will be conducted at the Abernethy Salmon Culture Technology Center (STSC) in cooperation with the USFWS. Spawning and rearing will be conducted during each of three years, beginning in 1999. Juveniles will be released into Rock Island Reservoir, which was chosen because of the lack of white sturgeon recruitment, and its relatively small size. Juvenile releases will occur at three specific age classes: age-0, age-1, and age 2. Evaluation will occur 1-2 years following releases, and will include comparisons of survival and growth among rearing and release strategies.

Task 1c-The USGS will conduct laboratory trials to determine the size at which white sturgeons are no longer vulnerable to predation by channel catfish and other benthic predators. Trials will be conducted at the USGS's Columbia River Research Laboratory in 1.5 m diameter circular tanks and a 12,300-l flowing water raceway. Methods will be similar to Gadomski and Hall-Griswold (1992) and Gadomski et al. (1994). Channel catfish will likely be collected from the wild, but may be purchased from an aquaculture facility. White sturgeon larvae will be obtained from an aquaculture facility in June and reared at the Columbia River Research Laboratory. Experiments will be conducted weekly from June through October at 16-18^{o}C to determine how predation rate changes with size of age-0 white sturgeon. Known numbers of age-0 white sturgeons will be introduced into tanks containing at least three predators, and ingestion rate will be determined by enumerating white sturgeons remaining at the end of a trial. Preliminary experiments will determine the appropriate numbers of prey and predators per trial, and appropriate duration of trials.

Task 1d-WDFW will be the lead agency in directing Zone 6 recreational fishery sampling and estimating white sturgeon harvest. ODFW will assist with activities that include: conducting ground counts of anglers and interviewing selected participants to estimate total fishing effort; sampling catches of selected participants to estimate numbers, lengths, gender, stage of maturity, and ages of fish handled and harvested; and documenting numbers of tagged fish harvested by anglers to estimate exploitation. CRITFC and the Yakama Indian Nation will assist with sampling the commercial fishery to estimate harvest. Landed catch will be sampled to estimate numbers, lengths, weights, ages, and gender of fish harvested. Numbers of tagged fish harvested will be documented to estimate exploitation. The subsistence fishery will be sampled by random and periodic surveys of tribal angling, dipnet, and setnet fishing activities. Landed catch in this fishery catch will be sampled to estimate numbers, lengths, weights, ages, and gender of fish harvested. Numbers of tagged fish harvested will be documented to estimate exploitation.

Objective 2 (Develop and implement mitigation actions that involve changes to hydrosystem operation and configuration).

Task 2a-The USGS will continue to use acoustic and radio telemetry during this second year of fieldwork to investigate the behavior of pre-spawn and spawning white sturgeons downstream from John Day Dam. Transmitters will be attached to 15 fish during January

and February, which will compliment the 15 transmittered fish that should still be present from work done in 1999. Mobile tracking from boats will be done weekly during March and April, and will be done daily when water temperatures are suitable for spawning (12-18^{o}C). Tracking will cease when mean daily water temperatures reach 20^{o}C. Locations of fish will be recorded with a global positioning system receiver. Locations and movements of individual fish will be portrayed and summarized with a geographic information system.

In addition to mobile tracking, a stationary data-logging radio receiver with directional antennas will be placed on an island within the known spawning area (approximately river mile 214) to record when fish enter and leave the area. Records of hourly dam operations (changes in turbine discharge, spill, and water elevations) will be compared with fish movements and locations to determine if fish are responding to changes in the hydraulic conditions that result from operations at John Day Dam.

Task 2b- The USGS and USFWS will provide estimates of the habitat available for spawning white sturgeons during 2000 by using hydraulic and habitat models constructed by Parsley and Beckman (1994) and the USFWS (in preparation). River discharges and water temperatures that occur during May through July will be used to construct a daily time series of weighted usable area for spawning downstream from Bonneville, The Dalles, John Day, McNary, Priest Rapids, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams.

The USFWS will complete the analysis and final report that describes the relationship between river discharge and the location and quantity of spawning and rearing habitat for white sturgeons in the free-flowing portions of the Columbia River between McNary and Priest Rapids dams, and in the Snake River downstream from Lower Granite Dam. Habitat information will be integrated with habitat suitability curves derived by the USGS to determine spawning and rearing habitat quality, quantity, and location as a function of river discharge. Time series analysis will be used for a comparison of spawning and rearing habitat prior to construction and operation of the hydrosystem to habitat under current conditions. Recommendations of options for hydrosystem operation that will maintain or enhance spawning and rearing habitat will be made.

Task 2c- The USGS will describe the potential effect of proposed reservoir drawdowns on white sturgeon habitat in the John Day Reservoir and in the Lower Snake River. Work done by others including Battelle's Pacific Northwest Laboratories, the Army Corps of Engineers, and the USGS has provided a spatially explicit physical habitat template that predicts conditions that may exist if the dams on the lower Snake River are breached or if reservoir levels in John Day Reservoir are lowered. We will make comparisons of the availability of habitat for white sturgeons under current and proposed conditions.

Objective 3 *(Monitor and evaluate actions to mitigate for lost white sturgeon production due to development, operation, and configuration of the hydropower system).*

Task 3a-The USGS will continue to use bottom trawls to sample in the Bonneville, The Dalles, and John Day reservoirs to document reproductive success in these areas. This sampling will be done during September, October, and November. In Bonneville Reservoir we will sample 11 sites, six times each over 12 days. In The Dalles Reservoir we will sample 12 sites, twice each over 4-6 days, and in John Day Reservoir we will sample 19 sites, twice each over 6-8 days. An analysis is underway to determine the level of effort needed at each site to achieve adequate statistical power in the indices.

We recognize that trawling cannot be conducted in many areas, and in 1997 the project began testing small-mesh gillnets to index recruitment. The USGS will determine if the

indices developed from trawling and gillnetting follow similar trends with changes in densities that result from variable recruitment. Thus, 2-inch stretched-mesh gillnets will be fished during October and November in The Dalles and John Day reservoirs, and catches will be compared to those from the bottom trawl.

Task 3b-WDFW, ODFW, and CRITFC will describe annual variation in white sturgeon recruitment from catches of age-0 fish in 24-hour gill net sets (2 inch stretched mesh) in The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, and Little Goose reservoirs, and in the Hanford Reach. Up to 100 standardized sites will be fished three times each. WDFW will provide two boats and 3 persons. ODFW and CRITFC will assist with personnel and preparation of gear.

Objective 4 (Assess losses to white sturgeon productivity caused by development and operation of the hydrosystem).

Task 4a-Laboratory trials will be done to determine if turbidity influences predation on age-0 white sturgeons by channel catfish or other benthic predators. Newly hatched age-0 white sturgeons will be obtained from an aquaculture facility. Replicated trials will be done at the USGS's laboratory in circular tanks during June through August. Tests will be conducted at temperatures of 16-18C and at turbidities ranging from ambient (< 5 NTU) to 200 NTU. Turbidity within the tanks will be maintained by the controlled addition of bentonite. Known numbers of age-0 white sturgeons will be introduced into tanks containing at least three predators, and ingestion rate will be determined by enumerating white sturgeons remaining at the end of a trial.

Task 4b-Oregon State University (OSU) will obtain adult white sturgeon from both commercial and recreational fisheries and also by coordination with agency biologists from the ODFW and the WDFW. Monitoring of sturgeon will be conducted in each of the three years of the study to determine variation in physiological parameters in relation to major ecosystem factors such as river flow and water temperature. Field studies will take place at a variety of locations on the Columbia River. Samples will be obtained from the estuary and in Bonneville, The Dalles, John Day and McNary reservoirs. On each sampling date and at each site, a minimum of 10 animals will be collected, resulting in a sample size of approximately 200 fish each year. Sampling will involve both lethal and nonlethal methods. Fish will be measured for body size (weight and fork length) and gonad weight, and sampled for gonads, and blood plasma.

At OSU, plasma samples will be analyzed for the sex steroids responsible for maturation (testosterone, 11-ketotestosterone, and estradiol-17?) by radioimmunoassay (Fitzpatrick et al. 1986). Each radioimmunoassay will utilize polyclonal antisera specific for each steroid. Calcium (an indicator of vitellogenesis) will be measured in plasma by a Sigma diagnostic kit. Gonads will be fixed in buffered formalin and embedded in paraffin. Serial sections (4 µm) will be taken sagittally and stained with hematoxylin and eosin. Descriptions of gametogenesis of white sturgeon, outlined by Doroshov et al. (1991; 1997) and Conte et al. (1988), will be used to identify stages of germ cell maturity. Gonadal samples will also be analyzed for sex ratios and possible intersex fish. Concentrations of calcium and all steroids will be compared over time and between locations, and between sexes of fish by using analysis of variance. Discriminant analysis of the data will also be performed to generate a general model for distinguishing between sexes and maturity states.

For disease assessment the following fitness characteristics will be recorded: length and weight; condition of body surface; fins and gills; size and appearance of internal organs; and presence of dermal lesions. Samples for bacteriology will be taken immediately from any lesions and from the kidney and inoculated onto standard bacteriological media. Portions of the kidney, spleen and gills will be removed for viral assay. Viruses will be detected either following incubation on a cell line derived from sturgeon (Hedrick et al.

1992) or by using molecular detection techniques. The external surface of the fish will be examined for any apparent parasites, and skin scrapings made for examination by light microscopy. Internal organs will be examined for macroscopic parasites using a dissecting microscope, and samples of abnormal tissues will be taken for histological examination. When feasible, samples of ovarian fluid and eggs will be obtained for viral and parasite assay. Data will be compiled and pathogen prevalence among sites, sexes and maturational status will be compared.

g. Facilities and equipment

Most major facilities and equipment to be used in the project currently exist and are being used. The project is headquartered in existing offices of the lead and cooperating agencies. Staff and facilities associated with the ODFW, WDFW, CRITFC, USGS, and USFWS collectively provide a long history of white sturgeon research and management expertise in the Columbia River basin. These facilities are all suitable for program needs relating to office, laboratory, and storage needs.

Offices are all equipped with computers to process and transmit data. All computers have Pentium processors, and are capable of processing large data sets. Software used for data analyses include SAS, SigmaPlot, and Microsoft Excel.

The CRITFC will be using facilities at the Abernethy Salmon Culture Technology Center for artificial propagation work. The Center includes an office complex, analytical laboratory, conference building, extended building for nutrition research, a combination hatchery and wet laboratory, a selective spawning building, standby generators, and storage facilities. Fish culture amenities include two wells with a combined flow of 4,000 gpm of pathogen-free 10-12^{o}C water, 12 raceways, a trapping and holding pond, and other features. White sturgeon have been on site for approximately 5 years, being used for a variety of nutrition and growth research.

The Oregon Cooperative Fishery Research Unit has three (3) laboratories on the campus of Oregon State University equipped with a Beckman L8-60M Ultracentrifuge, Beckman TJ-6 Benchtop Centrifuge, Beckman LS 1800 Liquid Scintillation Counter, Beckman DU-64 Spectrophotometer, Waters automated high performance chromatograph, incubators, three ultralow freezers, cryostat and automated histology apparatus, fraction collector, seven microcomputers, and standard laboratory equipment (homogenizers, glassware, pipets, etc.). All equipment and facilities are available for use in conducting the radioimmunoassays and histology. Research facilities available include rooms for cell culture and virology, incubators for bacteriology and all essential equipment for pathogen isolation and identification. Wet lab facilities include isolation and holding tanks.

A variety of boats and sampling gear designed to collect various life stages of white sturgeon are currently used on the project. Vehicles used include those appropriate for trailering and launching project boats.

h. Budget

The budget has decreased approximately 4% from FY 1999. The budget will continue to decrease in future years as research tasks are completed, and the project focuses on mitigation activities and monitoring those activities.

This project includes all work currently underway to mitigate and restore white sturgeon populations downstream from Lake Roosevelt in the Columbia River, and downstream

from Lower Granite Dam in the Snake River; however, funding comprises less than 2% of the total BPA budget for resident and anadromous fish projects. Funding for all sturgeon projects comprises only about 5% of the resident and anadromous fish budget.

Work performed by each cooperating agency is explained in Section 8f (Methods); however, the cost of specific work conducted under subcontracts totals $320,043, or 17% of the budget. The NMFS ($45,000) provides a trawling vessel, captain, engineer, and biologist to help ODFW conduct Task 1a. The NMFS has demonstrated expertise with trawling during previous years of this project. Oregon State University ($100,517) will conduct the analyses to evaluate maturational status of white sturgeon (Task 4b). This work will provide a non-invasive technique to determine sex and maturation status of white sturgeon in the field. The CRITFC will subcontract to the Yakama Indian Nation ($48,885) to provide intensive monitoring of the commercial fishery (Task 1d), and with the Abernethy Salmon Technology Center ($125,641) to provide facilities for holding and spawning of adult white sturgeon and rearing of juveniles (Task 1b).

Section 9. Key personnel

David Ward
Oregon Department of Fish and Wildlife
17330 S.E. Evelyn Street
Clackamas, OR 97015

Education

Humboldt State University (Arcata, CA)	M.S. Fisheries, 1985
Humboldt State University (Arcata, CA)	B.A. Zoology, 1978

Experience

1984-Present: Oregon Department of Fish and Wildlife; (1) Program Leader for Northwest Region Research Program (1998-Present): Coordinate activities of ongoing departmental and interagency projects, identify needs for and develop future projects, provide technical oversight to project leaders, and supervise project leaders and other program staff. (2) Project Leader: Evaluation of the Northern Pikeminnow Management Program (1991-98). (3) Project Leader: Portland Harbor Study (1988-91). (4) Project Biologist and Technician on various studies (1984-87).

Duties as Program Leader on Proposed Study: Coordinate and integrate activities of cooperating agencies; facilitate coordination of work and contracting with NPPC, CBFWA, and BPA, provide technical oversight for products, hire and supervise staff of project leaders and biologists. FTE: 4 months.

Expertise Coordinated and integrated activities of cooperating agencies, hired and supervised staff of project leaders, project biologists, and seasonal workers, designed field and laboratory sampling plans, analyzed wide variety of biological data, authored, edited, and reviewed scientific reports and peer-review articles. Developed and submitted proposals for numerous research projects to various funding sources.

Publications and Reports

Ward, D.L., and M.P. Zimmerman. In Press. Response of smallmouth bass to sustained removals of northern pikeminnow in the lower Columbia and Snake rivers. Transactions of the American Fisheries Society.

Friesen, T.A., and D.L. Ward. In Press. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. North American Journal of Fisheries Management.

Zimmerman, M.P., and D.L. Ward. In Press. Index of predation on juvenile salmonids by northern pikeminnow in the lower Columbia River basin from 1994-96. Transactions of the American Fisheries Society.

Beamesderfer, R.C., D.L. Ward, and A.A. Nigro. 1996. Evaluation of the biological basis for a predator control program on northern squawfish in the Columbia and Snake rivers. Canadian Journal of Fisheries and Aquatic Sciences 53:2898-2908.

Tom Rien
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Education:
Oregon State University (Corvallis) B.S. Wildlife Biology, 1981

Experience
1984-Present Oregon Department of Fish and Wildlife: (1) Project Leader for White Sturgeon Research (1.5 years). Current responsibilities: Principal Investigator for studies on the early life history and habitat use of white sturgeons in the Columbia River. Coordinate research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. Oversee the work of two biologists and several seasonal employees. (2) Project Biologist for studies on the early life history and habitat use of white sturgeons in the Columbia River (6.5 years); (3) Sub-Basin Planner for Clackamas and Lower Willamette rivers (1.5 years); (4) Project Technician and Biology Aide on various studies (4 years).

Duties as Principal Investigator. Coordinate research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. Oversee the work of two biologists and several seasonal employees. FTE - 12 months.

Expertise: Considered expert at aging and age evaluations of several fish species including white sturgeon; devloping and implementing sampling designs to describe population parameters; interpreting and applying findings in population models. Coordinated and integrated activities of cooperating agencies, hired and supervised staff of project biologists, and seasonal workers.

Publications and Reports
Beamesderfer, R.C.P., T.A. Rien, and A.A. Nigro. 1995. Dynamics and potential production of white sturgeon populations in three Columbia River reservoirs Transactions of the American Fisheries Society 124:857-872.

North, J.A., R.C. Beamesderfer, and T.A. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia River reservoirs. Northwest Science 67(2):105-111.

Rien, T.A. and R.C. Beamesderfer. 1994. Accuracy and precision in age estimates of white sturgeon from pectoral fin rays. Transactions of the American Fisheries Society 123(2):255-265.

Rien, T.A., R.C.P. Beamesderfer, and C.A. Foster. 1994. Retention, recognition, and effects on survival of several tags and marks on white sturgeon. California Fish and Game 80(4):161-170.

John D. DeVore
Washington Department of Fish and Wildlife
2108 Grand Boulevard
Vancouver, WA 98661

Education
Cornell University B.S. Fisheries, 1980

Experience
Fish Biologist 4, Washington Department of Fish and Wildlife, 11/89-present.
Program leader and species specialist in charge of the agency's research and management program for native sturgeon species. Plans, directs, and implements multiple programs that collectively assesses productivity of various white sturgeon populations residing within the state of Washington to understand population dynamics, factors limiting productivity, and utilization of critical habitats. Publishes research results in professional, peer-reviewed journals. Utilizes research results to design sustainable harvest strategies for various tribal, sport, and commercial fisheries in areas where productivity is sufficiently high and recovery strategies where productivity is critically low. Coordinates research and management activities with various international, federal, state, tribal, academic, and private entities.

Fish Biologist 2, Washington Department of Fisheries, 1/86-11/89.
Implemented the collection and analyses of coded-wire tag and catch and effort data for run reconstruction and run size forecasting of salmon runs in the Columbia River and it's Washington tributaries. Participated in run size forecasting of Columbia River coho salmon for input into the Oregon Production Index and Pacific Fisheries Management Council processes. Conducted stream surveys, fishery sampling, and random sampling of hatchery salmon escapements.

Duties as Principal Investigator. Coordinate research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. Oversee the work of two biologists and several seasonal employees. FTE - 12 months.

Special Skills
Advanced SCUBA (NAUI, PADI, and YMCA certifications)
Small boat handling and maintenance
Advanced computer and statistical skills
Public speaking skills

Professional Affiliations
The American Fisheries Society

Michael J. Parsley
U.S. Geological Survey-Biological Resources Division
5501A Cook-Underwood Road
Cook, WA 98605

Education:

Iowa State University	B.S. Fish & Wildlife Biology, 1982
University of Wisconsin (Stevens Point)	M. S. Fisheries, 1984

Experience

1984-Present U.S. Geological Survey - Biological Resources Division. (1) Project Leader on White Sturgeon Study. Current responsibilities. Principal Investigator for studies on the early life history and habitat use of white sturgeons in the Columbia River. Coordinate research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. Oversee the work of several biologists and technicians. Geospatial technology coordinator for the Western Fisheries Research Center. (2) Project Biologist, U.S. Geological Survey - Biological Resources Division.

Duties as Principal Investigator. Coordinate research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. Oversee the work of several biologists and technicians. FTE - 11 months.

Expertise. Use of biotelemetry to ascertain habitat use by juvenile and adult white sturgeons, laboratory experiments to determine the effects of gas supersaturation on developing embryos, and trawls to estimate recruitment to young of the year. In 1993, organized and co-chaired a day-long symposium called "Biology and Management of North American Sturgeons" that was held at the Annual Meeting of the American Fisheries Society, Portland, Oregon, Knowledgeable in methods to quantify habitat in large rivers using remote sensing and geographic information systems.

Publications and Reports

Counihan, T.D., A.I. Miller, M.G. Mesa, and M.J. Parsley. 1998. The effects of dissolved gas supersaturation on white sturgeon larvae. Transactions of the American Fisheries Society 127:316-322.

Counihan, T.D., A.I. Miller, and M.J Parsley. In press. Indexing the relative abundance of young-of-the-year white sturgeon in an impoundment of the lower Columbia River from highly skewed trawling data. North American Journal of Fisheries Management.

Parsley, M. J., and L. G. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Parsley, M. J., L. G. Beckman, and G. T. McCabe. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society 122:217-227.

Donald R. Anglin
U.S. Fish and Wildlife Service
9317 N.E. Highway 99, Suite I ·
Vancouver, Washington 98665

Education

Humboldt State University (Arcata, CA) B.S. Wildlife, Fisheries, Biology, 1975

Experience

Current Responsibilities:•Responsible for the Instream Flow section within the Habitat and Natural Production Section. Supervise five full time employees, support administrative functions, and manage budgets for approximately $400,000 per year. Technically responsible for study design, oversight of data collection, and analyses including report production, proposal preparation, and technical assistance. •Instream Flow Studies - Columbia, Snake, Clark Fork Rivers; target species - white sturgeon, fall chinook and chum salmon, rainbow trout. •Water Rights Cases - Snake River for white sturgeon and nesting waterfowl. Hydraulic modeling for island maintenance flows in the Snake River. Minimum flow determination -fall chinook and chum salmon spawning in mainstem Columbia River.

Duties as Principal Investigator: •Determine sampling design for hydraulic models and habitat models to characterize conditions for spawning and rearing white sturgeon in the Hanford Reach of the Columbia River and in the Lower Snake River. •Supervise data collection using Acoustic Doppler Current Profilers (ADCP), electronic total stations, GPS receivers, and underwater video. •Conduct and supervise data analysis for hydraulic and habitat modeling, quantify relationship between physical habitat and river discharge for spawning and rearing white sturgeon, determine location, quantity, and quality of spawning and rearing habitat, conduct time-series analysis of spawning and rearing habitat for comparison of habitat conditions during pre-hydrosystem and post-hydrosystem time periods, as well as for comparison of various operational scenarios.Budget management and report production. FTE – 6 months.

Publications and Reports

•Anglin, D.R. 1994. Report E *in* K. Beiningen, editor. Status and habitat requirements of white sturgeon populations in the Columbia and Snake Rivers upstream from McNary Dam. Annual Report to the Bonneville Power Administration (Project 86-50), Portland, Oregon.

•Anglin D.R., Cummings T.R., Ecklund A. E. 1992. Swan Falls Instream Flow Study. 255 pp. U.S. Department of the Interior, Fish and Wildlife Service, Vancouver, Washington.

•Anglin, D.R. 1994. Lower Klamath River Instream Flow Study. Scoping evaluation for the Yurok Indian Reservation. 46 pp. For the Bureau of Indian Affairs, by U.S. Department of the Interior, Fish and Wildlife Service, Vancouver, Washington.

•Anglin, D.R. 1997. Quantification of white sturgeon habitat in the Columbia River Basin. Presentation at the White Sturgeon Summit, December 18,1997, Vancouver, Washington.

Blaine L. Parker
Columbia River Inter-Tribal Fish Commission
729 NE Oregon Street, Suite 200
Portland, OR 97232

Education:

Montana State University	B.S. Fish and Wildlife Management, 1985
Idaho State University	M.S. Zoology, 1990

Experience

1991-Present Columbia River Inter-Tribal Fish Commission: (1) Project Leader for White Sturgeon Research and Management (1994-Present, 4 years). Current responsibilities: Coordinate white sturgeon research and management activities for the Commission and its member tribes. Includes stock assessment, commercial and subsistence fishery monitoring, enhancement planning, artificial propagation studies, and viral disease research. (2) Associate Project Leader for Northern Pikeminnow Dam Angling Predation Project. Included supervision of angling crews, volunteer program, personnel hiring and project logistics (1991-1993, 3 years).

Duties as Project Leader: Work cooperatively with appropriate tribal, state, and federal staff to procure and spawn wild white sturgeon broodstock, rear juvenile sturgeon, prepare appropriate NEPA documentation, mark and release juvenile sturgeon, prepare quarterly and annual reports, and plan out-year efforts. FTE: 12.0 months.

Expertise: Excellent skills in coordinating with diverse groups from a variety of agencies. Experience managing diverse projects with wide geographic range, multiple agencies, complicated logistics, and sensitive issues. Technical skills include data management, writing and editing journal articles, working knowledge of sturgeon artificial propagation and husbandry, and white sturgeon ecology.

Publications and Reports

LaPatra, S.E., B.L. Parker, and J.M. Groff. 1996. Epidemiology of viruses in white sturgeon in the Pacific Northwest. In Proceedings of the WRAC Sturgeon Broodstock Management Workshop. College of Southern Idaho, Twin Falls. September 27-28, 1996.

TAC. 1997. 1996 All Species Review, Columbia River Fish Management Plan. U.S. v. Oregon Technical Advisory Committee. August 4, 1997

Parker, B.L., S.E. LaPatra, J.M. Groff, and R.J. Munn. 1997. Isolation of a novel adeno-type virus from wild Columbia River white sturgeon. Pathogens and Diseases of Fish in Aquatic Ecosystems: Implications in Fisheries Management. June 3-4, 1997. Portland, Oregon.

LaPatra, S.E., B.L. Parker, J.M. Groff, H. M. Engelking, J. Kaufman, and R.J. Munn. 1998. Epidemiology of viral infections in white sturgeon from the Pacific Northwest. Pages in Proceedings of the 49th Annual Northwest Fish Culture Conference. Boise, Idaho.

Section 10. Information/technology transfer

Information collected from the project is shared with fishery managers and is used to help develop or revise the management of white sturgeon fisheries. One example is information on population status of white sturgeon gathered as part of the project is used to set maximum harvest limits in impoundments.

Annual reports summarizing each year's activities and results are published by BPA. Special reports summarizing major findings have also been published. The most recent of these was a report summarizing 1986-92 results and recommendations (Beamesderfer and Nigro 1993). Numerous manuscripts based on findings from the project have been published in peer-review journals. A list of these publications is given in Section 7d. Publication in peer-review journals will continue as the project progresses.

The project has also shared information through symposia and workshops. A workshop organized by project cooperators in December 1997 was attended by sturgeon biologists from throughout the Pacific Northwest.

Congratulations!